

REMARKS

The Examiner is thanked for the telephone interview held on Dec. 2, 2004. In the interview, claims 1 and 50 were discussed. With regards to claim 1, the top and peripheral regions were discussed. The Examiner believed that peripheral region can be read into the top region. The undersigned disagreed. While not discussed in the interview, it should be pointed out that this argument has already been discussed in great detail in earlier responses. As stated in the AF response filed July 17, 2002:

'In rejecting claim 1, the Examiner states that under a broad interpretation of the word "region," *Suzuki* teaches flowing gas into a top central region 36A. (Final Office Action, pages 6-7). In other words, the Examiner asserts that a top region can be a region at the periphery of a substantially cylindrical plasma processing system. The undersigned earnestly believes that this broad interpretation is not reasonable since it should be known to those skilled in the art that the top region of a substantially cylindrical plasma processing system cannot be a region that is on the periphery of the cylindrical plasma processing system.'

Nevertheless, solely in order to expedite prosecution, claim 1 has been amended. Claim 1 recites flowing gas into at least two different regions, including at least one top region located at a top surface of the substantially cylindrical plasma processing chamber and a second region being a peripheral region located on a surface surrounding the periphery of the substantially cylindrical plasma processing chamber. It should be noted that for a substantially cylindrical plasma processing chamber, the top and peripheral surfaces are well understood to those skilled in the art. In fact, the undersigned earnestly believes that the distinction between the top and peripheral surfaces of a cylindrical object is a matter of common knowledge.'

With regards to claim 50, the limitation, "releasing the identical said input gas formed by said mixture of gases into the chamber," was discussed in conjunction with references Li 551, Li 830 and Yamakazi 810.

No agreement was reached in the interview.

In the Office Action, the Examiner rejected claims 1-11, 16, 17, 19, 23-33, 35-37, 39, 42-50 and 52-56 under 35 USC § 102 and/or 103. These rejections are fully traversed below.

Claims 5, 6, 9, 10, 19, 25, 28, 29, 35, 36, 48 and 50 have been amended. Claims 11, 37, 39-41, 46, 47, 49, 51-53, 55 and 56 have been cancelled. Claims 57 - 65 have been added. Thus, claims 1-11, 16-17, 19, 23-33, 35, 36, 42-45, 48, 50, 54, and 57-65 are pending in the application. Reconsideration of the application is respectfully requested based on the following remarks.

The present invention is part of a group of applications (all of which are incorporated by reference) directed at azimuthally symmetric processing. It is believed that azimuthally symmetric processing provides better control and more uniform processing at the surface of the

substrate. With regards to the present invention described herein, a gas flow system is configured to carry and distribute the same gas mixture (from the same source) to different outlets, and to control the amount of gas through each of the outlets. The invention allows a set single gas mixture with a single sum total flow (sccm) to be split or rationized to multiple portions of the chamber. By rationizing the gas at different regions, the gas may be distributed more evenly inside the process chamber (which as a result can produce more uniform results across the surface of the substrate). Furthermore, the gas mixture being delivered to each region is the same (e.g., from the same source) thereby reducing variations caused by delivering a different gas mixture to each of the regions. It should be noted that even if two independent gas supplies used the same recipe to produce the same gas mixture, there would be differences in the outputted gas mixture (different independent gas sources cannot make exactly the same gas). These differences lead to process variations. Further still, the gas being delivered to each region is symmetrically distributed in each region. For example, a gas ring having a series of holes substantially equidistant about the periphery of the ring or a gas distribution plate with symmetrically patterned holes can be used.

This is not the case in the cited references. In the cited references, different gases are fed individually into different portions of the chamber and in some cases the gases are only fed into one region of the chamber. As a result, process variations may be produced during processing. Furthermore, their systems are much more complex and likely to send to much gas (or are actually set to prevent the ability to send to) a single gas outlet. Their systems are set to prevent mixing or they have independent controls so their gas mixture setting MFCs are all driven independently with reasonable pressure drops across them. If they put all their flows together, their MFCs would have very little pressure drop across them and fail to control and hence lead to failure to control the mixture of the total flow. Moreover, the references do not describe azimuthally symmetric distribution of gases.

In brief, *Li* (6070551) feeds multiple gases individually and is all about being able to deliver different mixtures. In contrast, the present invention feeds a single mixture thereby always ensuring the same mixture is fed to the different regions. *Muregesh* (6228781) is all about delivering different gases, purging, managing cleaning, etc. They have many flow controllers 35A-A', 35B-B', etc. that go to multiple areas thereby making it very difficult to perform key element of the present invention, i.e., adjusting the gas ratio with a sure identical single mixture. *Collins* (6024826) teaches seven independent gas supplies, which is very

complex and difficult to control. In contrast, the present invention feeds a single mixture thereby always ensuring the same mixture is fed to the different regions. In addition, *Collins* does not teach ratioing to different regions. *Li* (6009830) mixes gas inside delivery lines and needs to set individual flows into the delivery lines to set ratio. Mixture and sub-total flow set by 68/72 goes to 56-54 while user must independently specify another mixture and total flow set by 70/74 going to 52/38 to ensure ratio of same mix with sum total gas delivered. In contrast, the present invention makes it easy to use a standard gas box with a bunch of MFCs to set a single gas mixture with a single sum total flow (sccm) that is then split by setting a single ratio to two different portions of the chamber.

With regards to the new references, *Fujii* does not deliver the same gas to two different regions. *Fujii* only delivers gas to a top region. Furthermore, the pipes are not azimuthally symmetric, but rather inline (see Fig. 7). *Fujiyama* discloses gas emitting tube 4 and gas emitting ring 9 that emit different gases at different times and thus the flow of a single gas is not controlled or rationized to two different regions. *Yamakazi* does not deliver gas to two different regions, and further does not control or rationize the exiting gases. In all three references, azimuthal symmetry is not described.

It should be pointed out that each of these references discloses a gas system that should be taken in totality. Pieces should not be taken from one and added to another. Each of these systems is a system and therefore the addition of another element would surely effect the proper functioning of the system in a non-trivial manner. One skilled in the art would simply not be motivated to combine the teachings of the various components of these systems to come up with the claimed invention. Furthermore, it is believed that the motivation to combine should come from something other than the fact that these are gas systems since each of these gas systems operates in a substantially different manner.

ISSUES UNDER 35 USC 102

Claims 50 and 52 have been rejected under 35 U.S.C. §102(b) as being anticipated by *Li et al.*, U.S. Patent 6,009,830.

In contrast to *Li*, claim 50 (and its dependents) specifically requires, "...a plurality of outlets arranged to deliver the same said input gas to different locations within said plasma

process chamber, a first outlet being configured to deliver said input gas to said first output, a second outlet being configured to deliver said input gas to said second output, said gas flow controller directing at the same time varying amounts of said identical input gas to each of said first and second outputs so as to provide better process control, a first portion of the total flow of the input gas being delivered through the first outlet to the first output, and a remaining portion of the total flow of the input gas being delivered through the second outlet to the second output."

In *Li*, different gases (NOT the same gas) are fed individually into different portions of the chamber. *Li* states on Col. 2, lines 66-67 and Col. 3 lines 1-5, "We have found that better uniformity can be achieved by independently controlling injecting different components of the processing gas from different parts of the chamber. Oxide etching uniformity is greatly improved by injecting the active etching components from ports around the periphery of the wafer and by injecting the carrier gas from a showerhead above the wafer." *Li* also states, "The showerhead directs its gas toward the face of the wafer...(Col. 3, lines 45-46)," and "The bottom gas feed 38...directs its gas upwardly way from the wafer (Col. 3, lines 54-55)." *Li* also states, "In the preferred embodiment, as shown in Fig. 2, the processing gas consists of an etchant gas, for example, C4F8..., and a carrier gas of argon supplied from respective sources 64 and 66...(Col. 5, lines 4-7), " and "it has been found that supplying the C4F8 etchant source gas only to the bottom gas feed and supplying Ar carrier gas only to the top gas feed produces the best performance...(Col. 5, lines 44-47)" Accordingly, the rejection is unsupported by the art and should be withdrawn.

ISSUES UNDER 35 USC 103

Claims 1, 3, 5, 7-11, 16-17 and 56 have been rejected under 35 U.S.C. §103(a) as being unpatentable over *Li '830* in view of *Fujii* et al (4,980,204) or *Fujiyama* et al. (4,529,474) or *Yamakazi* (4,105,810).

Claims 1- 5, 7-11, 16-18, 50, 52 and 56 have been rejected under 35 U.S.C. §103(a) as being unpatentable over *Li '551* et al (6,070,551) in view of *Fujii* et al (4,980,204) or *Fujiyama* et al. (4,529,474) or *Yamakazi* (4,105,810).

Claims 1- 5, 7-9, 16-17, 19, 23-25, 28-33, 35, 37, 39, 42-44, 46, 48, 50 and 52-56 have been rejected under 35 U.S.C. §103(a) as being unpatentable over *Collins* et al (6,024,826) in view of *Fujii* et al (4,980,204) or *Fujiyama* et al. (4,529,474) or *Yamakazi* (4,105,810).

Claims 1- 5, 7-11, 16-17, 19, 23-34, 35, 37, 42-44, 46, 48 and 53-54 have been rejected under 35 U.S.C. §103(a) as being unpatentable over *Muregesh* et al (6,228,781) in view of *Fujii* et al (4,980,204) or *Fujiyama* et al. (4,529,474) or *Yamakazi* (4,105,810).

Claim 1

In contrast to all of the references, claim 1 (and its dependents) specifically requires, "said gas flow system controlling flow of a single input gas comprising a mixture of etchant source gases into at least two different regions of said plasma processing chamber....at least a first portion of said input gas being delivered to said plasma processing chamber via said first outlet and a remaining portion of said input gas being delivered to said plasma processing chamber via said second outlet." As mentioned by the Examiner, *Li 830*, *Li 551*, *Collins* and *Muregesh* do not disclose this limitation thus relying on support from the other references *Fujii*, *Fujiyama* and *Yamakazi*. These references, however, also fail to teach or suggest such a limitation.

In *Fujii*, the four vent pipes 111-114 are only located at the top of the reactor chamber 5 and thus gases are not delivered to two different regions. That is, they only deliver to a top region. It should be pointed out that as further required by claim 1 the two different regions

include at least a peripheral region and a top region. A peripheral region is simply not taught in *Fujii*. Accordingly, the rejection is unsupported by the art and should be withdrawn.

In *Fujiyama*, the gas emitting tube 4 and gas emitting ring 9 emit different gases and thus the flow of a single gas is not controlled to two different regions. As stated in *Fujiyama*, "silane gas from a starting gas tank 7 is emitted through a starting gas emitting tube 4 into the reaction chamber (Col. 2, lines 43-45)...a gas mixture of carbon tetrafluoride and oxygen in gas mixture container 8 is introduced into the reaction chamber through an etching gas emitting ring 9 (Col. 2, lines 59-63)." Furthermore, it should be noted that the emission of these two different gases is performed at different times and thus it cannot be the same gas. One is associated with a starting gas feeding system and the other is associated with an etching gas feeding system. Accordingly, the rejection is unsupported by the art and should be withdrawn.

In *Yamakazi*, the gases are only introduced at a top region as shown by Fig. 1 and thus gases are not delivered to two different regions. See *Fujii* above. It should further be pointed out that the exiting gases are not controlled and thus they are not rationized as further required by the claim. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Although the rejections to the dependent claims 2-5, 7-10, 16, 17, and 57-62 should be withdrawn for at least the reasons as above, it should be noted that they offer additional language that is unsupported by the art. For example,

Claim 19

In contrast to all of the references, claim 19 (and its dependents) specifically requires, "...said gas flow system separating and directing the flow of the same single input gas, associated with forming a plasma, at the same time into at least two different regions of said plasma processing chamber, said at least two different regions ... at least a first portion of said input gas being delivered to said upper peripheral region and a remaining portion of said input gas being delivered to said top central region..." As mentioned by the Examiner, *Collins* and *Muregesh* do not disclose this limitation thus relying on support from the other references *Fujii*, *Fujiyama* and *Yamakazi*. These references, however, also fail to teach or suggest such a limitation (see above).

Also in contrast to all these references, claim 19 specifically requires, "...an azimuthally symmetric gas distribution system comprising at least a gas ring that supplies a portion of said single input gas to the upper peripheral region, the gas ring including a series of holes substantially equidistant about the periphery of the gas ring." No such feature is taught in any of the references. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Although the rejections to the dependent claims 23-25, 28-33, 35, 42-45, 48 and 54 should be withdrawn for at least the reasons as above, it should be noted that they offer additional language that is unsupported by the art. For example,

Claim 50

In contrast to all the references, claim 50 (and its dependents) specifically requires, "...a plurality of outlets arranged to deliver the same said input gas to different locations within said plasma process chamber, a first outlet being configured to deliver said input gas to said first output, a second outlet being configured to deliver said input gas to said second output, said gas flow controller directing at the same time varying amounts of said identical input gas to each of said first and second outputs so as to provide better process control, a first portion of the total flow of the input gas being delivered through the first outlet to the first output, and a remaining portion of the total flow of the input gas being delivered through the second outlet to the second output." In both *Li* and *Collins*, different gases (NOT the same gas as required by the claim) are fed individually into different portions of the chamber. This allows an operator to deliver different mixtures into the process chamber.

Li states, "In this embodiment, the present invention preferably supplies a combination of SiF4 and oxygen from first gas source for introduction into chamber 18 through orifices 38 of nozzles 34...Silane (SiH4) is preferably delivered into chamber 18 from second gas source 35a through second gas controller 37a and through nozzles 34a. In addition, third gas source 58 is preferably used to introduce silane (or for example a mixture of silane and SiF4) into chamber 18 from above substrate 20. In conjunction with this, oxygen is also directed into chamber 18 from position above substrate 20, but along a flow path separate from the flow path of the silane through pathway 70 and annular orifice 76 (Col. 5, lines 14-27)."

As shown in the various Figures of *Collins* as for example Fig. 8, *Collins* shows seven independent gas supplies. Although the independent gas supplies may supply similar gases they do not deliver the same identical gas since they are independent of one another. Furthermore, *Collins* also fails to teach or suggest ratioing to different regions. That is, *Collins* does not teach adjusting the amount of the input gas that is delivered to each of said first and second outputs.

Again, it should be emphasized that the present invention simultaneously feeds a single mixture to different regions of the process chamber. As a result, the same mixture is always being delivered to the different regions. The total gas flow at the inlet is equal to the sum of the gas flow at the outlets. This is simply not done in *Li* or *Collins*.

Fujii, *Fujiyama* and *Yamaguchi* do not overcome the deficiencies of *Li* and *Collins*. In *Fujii*, the four vent pipes 111-114 are only located at the top of the reactor chamber 5 and thus gases are not delivered to two different regions. In *Fujiyama*, the gas emitting tube 4 and gas emitting ring 9 emit different gases and thus the flow of a single gas is not controlled to two different regions. In *Yamakazi*, the gases are only introduced at a top region and the exiting gases are not controlled and thus they are not rationized. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Claim 6 has been rejected under 35 U.S.C. §103(a) as being unpatentable over *Li* et al (6,009,830) in view of *Fujii* et al (4,980,204) or *Fujiyama* et al (4,529,474) or *Yamakazi* (4,105,810) as applied to claims 1, 3, 5, 7-11, 16-17 and 56 above and further in view of *Wing* et al (6,277,235).

Claim 6 has been rejected under 35 U.S.C. §103(a) as being unpatentable over *Li* et al (6,070,551) in view of *Fujii* et al (4,980,204) or *Fujiyama* et al (4,529,474) or *Yamakazi* (4,105,810) as applied to claims 1-5, 7-11, 16-18, 50, 52 and 56 above and further in view of *Wing* et al (6,277,235).

Claims 6, 36 and 49 have been rejected under 35 U.S.C. §103(a) as being unpatentable over *Collins* et al (6,024,826) in view of *Fujii* et al (4,980,204) or *Fujiyama* et al. (4,529,474) or *Yamakazi* (4,105,810) as applied to claims 1-5, 7-9, 16-17, 19, 23-25, 28-33, 35, 37, 39, 42-44, 46, 48, 50 and 52-56 above and further in view of *Wing* et al (6,277,235).

Claims 6, 36 and 49 have been rejected under 35 U.S.C. §103(a) as being unpatentable over *Muregesh* et al (6,228,781) in view of *Fujii* et al (4,980,204) or *Fujiyama* et al. (4,529,474) or *Yamakazi* (4,105,810) as applied to claims 1-5, 7-11, 16-17, 19, 23-34, 35, 37, 42-44, 46, 48 and 53-54 above and further in view of *Wing* et al (6,277,235).

Wing does not cure the deficiencies of the cited art. All of the references fail to teach or suggest a gas flow system that controls the flow of a single input gas comprising a mixture of etchant source gases into at least two different regions of a plasma processing chamber. Accordingly, the rejection is unsupported by the art and should be withdrawn.

Furthermore, claim 6 specifically requires, "...wherein the input gas is released through the chuck." *Li*, *Murugesh* and *Collins* are all silent to introducing a gas through a chuck (as indicated by the Examiner in the outstanding office action). And while *Wing* may disclose aperture 8 centrally located in the surface of the chuck 106, *Wing* does not teach or suggest flowing a source gas suitable for use to etch the substrate in the processing chamber 100 through the aperture 108. In *Wing*, gas such as He is supplied to the backside of the substrate from gas source 118 and aperture 108 to improve heat transfer and control substrate backside deposition (see Col. 3, lines 49-55). Accordingly, the rejection is unsupported by the art and should be withdrawn.

Similar arguments can be made for claims 36 and 49.

Claims 45 and 47 have been rejected under 35 U.S.C. §103(a) as being unpatentable over *Collins* et al (6,024,826) in view of *Fujii* et al (4,980,204) or *Fujiyama* et al. (4,529,474) or *Yamakazi* (4,105,810) as applied to claims 1-5, 7-9, 16-17, 19, 23-25, 28-33, 35, 37, 39, 42-44, 46, 48, 50 and 52-56 above and further in view of *Ueda* et al (5,810,932) and *Kadomura* (6,096,160).

Claims 45 and 47 have been rejected under 35 U.S.C. §103(a) as being unpatentable over *Muregesh* et al (6,228,781) in view of *Fujii* et al (4,980,204) or *Fujiyama* et al. (4,529,474) or *Yamakazi* (4,105,810) as applied to claims 1-5, 7-11, 16-17, 19, 23-34, 35, 37, 42-44, 46, 48 and 53-54 above and further in view of *Ueda* et al (5,810,932) and *Kadomura* (6,096,160).

The rejections to claims 45 and 47 should be withdrawn for at least the same reasons as above. That is, *Ueda* and *Kadomura* do not overcome the deficiencies of *Murugesh* or *Collins* and further *Fuji*, *Fujiyama* and *Yamakazi*. None of these references teaches or suggests the features described above with regards to claims 19 and 37 from which claims 45 and 47 respectively depend.

Claims 10-11 and 26-27 have been rejected under 35 U.S.C. §103(a) as being unpatentable over *Collins* et al (6,024,826) in view of *Fujii* et al (4,980,204) or *Fujiyama* et al. (4,529,474) or *Yamakazi* (4,105,810) as applied to claims 1-5, 7-9, 16-17, 19, 23-25, 28-33, 35, 37, 39, 42-44, 46, 48, 50 and 52-56 above and further in view of *Li* et al (6,070,551).

The rejections to claim 10 should be withdrawn for at least the same reasons as above. That is, *Li* does not overcome the deficiencies of *Collins* and further *Fuji*, *Fujiyama* and *Yamakazi*. None of these references teaches or suggests the features described above with regards to claim 1 from which claim 10 depends.

In addition, none of the references teach or suggest, "wherein said plasma processing system further comprises a gas delivery ring that is fluidly coupled to said first outlet, and positioned on an upper portion of the plasma processing chamber, the gas delivery ring including a series of holes substantially equidistant about the periphery of the gas delivery ring, the first portion of said input gas being delivered into said upper peripheral region of said plasma processing chamber through said series of holes," as required by claim 10.

Moreover, it is believed that one skilled in the art would not be motivated to combine *Collins* with *Li* in order to produce the claimed invention. As shown in Fig. 18, 164b is positioned in a sloped or domed section of the chamber. This would make it extremely difficult to use a gas ring. Accordingly, the rejection should be withdrawn.

NEW CLAIMS (57-65)

Claim 57

In contrast to all the references, claim 57 specifically requires, "...an azimuthally symmetric gas distribution system ... the first gas outlet supplying said first portion of said input

gas to the gas channel, the gas channel equally distributing the first portion of said input gas through each of the holes in the gas delivery ring, and the holes feeding the first portion of said input gas into the upper peripheral region of the process chamber." It appears that no such feature is taught in any of the cited references, and therefore the claim should be allowed.

Claim 58

In contrast to all the references, claim 58 specifically requires, "...wherein the azimuthally symmetric gas distribution system further includes a gas distribution plate that supplies the remaining portion of said single input gas to the top central region, the gas distribution plate having a pattern of holes, the gas distribution plate being fluidly coupled to the second gas outlet." No such feature, and further no such feature in combination with the features of claim 57 from which claim 58 depends is taught in any of the cited references. The claim should therefore be allowed.

Claim 59

In contrast to all the references, claim 59 specifically requires, "...wherein gas delivery ring includes 16 holes configured an equal distance from each other." It appears that none of the references teach or suggest releasing gas from a ring that contains 16 holes, which are positioned an equal distance from each other. The claim should therefore be allowed.

Claim 60

In contrast to all the references, claim 60 specifically requires, "...a vacuum plate positioned above the inner wall of the plasma processing chamber, the vacuum plate cooperating with the plasma processing chamber to form a processing region above the substrate, the vacuum plate including an opening at its center, the opening in the vacuum plate being fluidly coupled to the second outlet; and

a gas delivery ring provided between the vacuum plate and an upper surface of the inner wall, the gas delivery ring having a series of holes substantially equidistant about the periphery of the gas delivery ring, the series of holes being fluidly coupled to the first outlet, and being placed near the vacuum plate, and

wherein the first portion of the input gas is supplied to the upper peripheral region of the plasma processing chamber via the holes in the gas delivery ring, and wherein the remaining portion of the input gas is supplied to the top central region of the plasma processing chamber via the opening in the vacuum plate.” It appears that no such combination is taught in any of the references and therefore the claim should be allowed.

Claim 61

In contrast to all the references, claim 61 specifically requires, “...wherein a seal is provided between the gas delivery ring and the vacuum plate and between the upper surface of the inner walls and the gas delivery ring.” It appears that each of the references is silent to seals located between a vacuum plate, which is positioned above the inner wall and a gas delivery ring, which is located between the vacuum plate and the inner wall. Accordingly, the claim should be allowed.

Claim 62

In contrast to all the references, claim 62 specifically requires, “...wherein the top central region is located directly above the substrate to be processed, and the upper peripheral region is located along the inner walls of the plasma processing chamber near the top central region.” It appears that no such arrangement is taught in any of the references and therefore the claim should be allowed.

Claim 63

In contrast to all the references, claim 63 specifically requires, “...wherein the first output corresponds to a gas distribution plate having a pattern of holes, and wherein the second output corresponds to a gas ring having a series of holes substantially equidistant about the periphery of the gas ring.” It appears that no such arrangement is taught in any of the references and therefore the claim should be allowed.

Claim 64

In contrast to all the references, claim 64 specifically requires, "...wherein the first output is vacuum plate having a centrally located opening, and wherein the second output is a gas ring having a series of holes substantially equidistant about the periphery of the gas ring." It appears that no such arrangement is taught in any of the references and therefore the claim should be allowed.

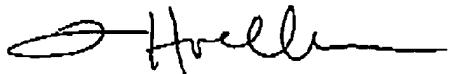
Claim 65

In contrast to all the references, claim 65 specifically requires, "...wherein gas ring is located next to the vacuum plate." It appears that no such arrangement is taught in any of the references and therefore the claim should be allowed.

SUMMARY

Applicant believes that all pending claims are allowable and respectfully requests a Notice of Allowance for this application from the Examiner. Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the undersigned can be reached at the telephone number set out below.

Respectfully submitted,
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